HIGH-RESOLUTION INFRARED SPECTROSCOPY OF CH_5^+

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CH_5^+ has been a challenge to spectroscopy for over fifty years. Theoretical calculations predict several structures with negligible energy barriers between them, which would produce a complicated vibrational spectrum. Indeed, this spectrum has been measured previously but no assignments of the transitions were made.

We have used high-resolution infrared spectroscopy to observe the spectrum of CH_5^+ in the C-H stretch region (2825-3050 cm^{-1}). The spectrum was taken under jet-cooled conditions, with a temperature of approximately 10K. CH_5^+ was produced via proton transfer between CH_4 and H_3^+ in a slit-jet discharge source. This synthesis results in a characteristic "titration curve" for the CH_5^+ lines, which decrease in intensity with an increase in methane concentration, at a rate corresponding to the exponential decrease in H_3^+. This new spectrum contains fewer lines (by about a factor of four) than the high-temperature experiment, and we have confirmed many of the transitions previously observed. In addition, we have identified numerous lines not present in the high-temperature spectrum. These data offer insight into the spectroscopy of this ion at low temperatures, and are a preliminary step toward an understanding of its vibrational energy structure.